Solar Energy and Its Thermal Application: A Case Study of Pakistan

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Abstract: **This paper is an endeavor to debate and focus the use of solar energy in Pakistan and to overwhelm the power demands in the state. The energy usage in all urban cities of Pakistan with the cost reduction and future technological developments along with its thermal applications. Energy crisis has resulted as a consequence of trends in globalization and increase in advancement of technology and industrialization. The need of energy based industries has increased the demand for energy resources. It is however, crucial to recognize and accept the fact that energy resources are on the verge of not only depletion but their degradation; exploitation and extensive use can also put them on the road to extinction. Sustainability of energy resources can build up a nation's base towards development and long-lasting survival. The paper will discuss the solar energy usage in all urban cities of Pakistan as alternative fuel and clean energy with the cost reduction and future technological developments.**

Keywords Solar Energy, Clean Energy, Alternative Fuels, Environment, Sustainable Development

I. INTRODUCTION:

Every day the human race consumes a million of billion kilojoules of energy by burning fuel. The available energy sources are oil, gas, coal, nuclear and wood. The fossil fuels (oil, gas and coal) provide 85% of the world's commercial primary energy, while 4% comes from nuclear. Nowadays Pakistan is facing energy shortage in all areas of life. Where the energy demand now is 22,000 MW and the energy generations is 17,000 MW and shortage is now 5000 MW. The reason of this shortage is very limited fossil fuel resources and low work on other resources (solar, wind, coal and hydropower). Pakistan is positioned in the expanse of the world where solar radiation is so much high. Solar energy has a great potential for Pakistan to meet the demands of energy in all urban areas. Pakistan Urban Cities have solar insolation about whole the year. Elective and sustainable assets of electrical vitality are required to stick pack this request. Pakistan is confronting a vitality deficiency, and the greater parts of the northern regions are still not electrified. Vitality free market activity hole is expansive. Because of a vitality deficiency urban territories are confronting 10– 12 hours stack shedding while in provincial regions power stays inaccessible for 16– 18 hours. This paper is an attempt to discuss and highlight the use of solar energy in Urban Cities of Pakistan and to overcome the energy demands in Urban Cities. The paper will discuss the energy usage in all urban cities of Pakistan with the cost reduction and future technological developments. The paper has the details of all energies which Pakistan is using, the current power situation, and the solution of energy shortage and uses of solar energy in urban cities. Pakistan is facing an immense energy shortage now a day and due to this energy deficit in metropolitan areas. Pakistan is facing 8 to 12-hour load shedding while rural areas are facing 12 to 16 hours' load shedding. Most of the northern areas and some of rural areas are still not electrically powered. The energy production and requirement gap is very enormous. Pakistan has constrained assets of petroleum derivative and this sum isn't satisfying the vitality request. Presently a day's Pakistan is working for sustainable power source frameworks and numerous ventures are continuous and numerous will be executed soon to conquer the vitality emergencies.

Pakistan is located between latitude 24'37° North and longitude 62'75° on the map of the world. Pakistan has the area of 803,950 square kilometers including FATA. Pakistan is arranged in the most extreme sun oriented disengagement zone in the Earth. To conquer the vitality deficiency in Pakistan it is important to augment natural vitality assets like hydropower, sun powered and wind. Pakistan has four provinces and the largest province (by area) is Baluchistan. If we Use solar system in just 25% area of Baluchistan we can make that much energy which can fulfill our country energy requirements. Deserts of Pakistan can also be used for this purpose. Some private sector companies also working on renewable energy and people of Pakistan are now using solar energy at their homes in limited quantity. As the time go the usage of solar energy in houses and offices will increase because it is not as costly as compare to buying electricity from other sources. It is just one time cost and profit is of long time.

The Government of Pakistan has lot an ambitious focus of having no less than 5% of the aggregate power genesis of the nation (i.e. 9700 MW) through option vitality by 2030 that would have a plummet share originating from sun powered power. The areas where the solar insolation is so high and have a largest area are most part of Baluchistan Province, Thal Desert in Punjab, Thar Desert in Sindh and Cholistan Area. These are the areas where barren land is available and solar plants can be implemented there. Currently Pakistan is making a fair amount of power from solar energy.

II. GEOGRAPHY OF PAKISTAN

Coordinates of Pakistan are 241 to 271N and 611 to 761 E respectively. It is divided in 5 provinces namely Khyber Pukhtoonkhawa (KPK), Punjab, Baluchistan, Sind and Gilgit Baltistan. Some major areas and cities are shown in Fig. 1.

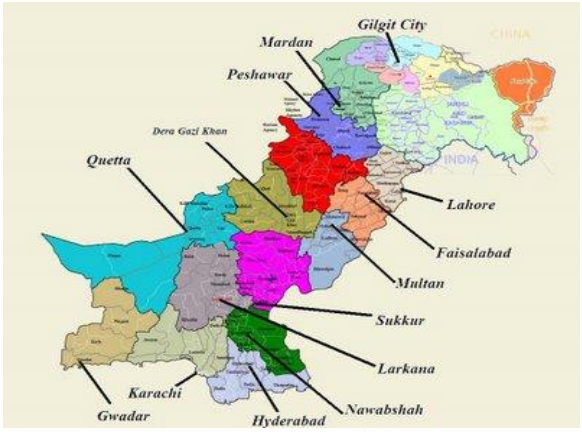

Fig. 1. Geographic Map of Pakistan

III. CURRENT ENERGY SITUATION IN PAKISTAN

With an extensive populace of 200 million and a quickly expanding economy, Pakistan needs a conceivably colossal vitality. At present Pakistan is confronting a normal shortage of 5000-5500 MW of power. The request of vitality is expanding and there is a need to change to elective wellsprings of vitality generation to satisfy the request.

As indicated by the Planning Commission's Medium Term Development Framework 2005-2010, with a specific end goal to meet the readiness for the financial development rate at 7% annually, vitality shortfall is relied upon to fuel to exacerbate levels of 46% by 2015 and 64% by 2025.

Power lack likewise tends to increment even in the winter season at the most reduced level in repositories of the dams and request of flammable gas in residential level. The premier sanities for vitality supply and requests are:

- Intermittent (in summer) volatility in the limit of hydropower assets
- Thermal control plants have lack of gas supply in winters.
- Erratic supply of heater oil to warm power plants.
- Sustenance and review of power plants.

IV. PAKISTAN'S ENERGY MIX

The essential vitality supply adds up to more than 70 million Tons of Oil Proportionate (TOE). Oil and gas are by a long shot the ruling sources with an offer of 80%. Oil is foreign made from the Center East fundamentally Saudi Arabia, gas from Iran. What's more, Pakistan is devouring Melted National Gas (LNG), Condensed Oil Gas (LPG) and coal. Pakistan has as of now, 4 control plants with a whole volume of 755 MW; extra 3 are under development. Atomic power represents around 1.9% of the aggregate introduced limit in Pakistan. Hydropower has an offer of 13% while other sustainable power sources just assume a minor part.

The legislature is supporting the utilization of LPG for cooking bringing about fast interest underway, stockpiling and foundation of auto stations of LPG. Amid the FY 2016, an inexact speculation of PKR 2.38 billion has been made in the LPG supply framework while add up to interest in the area until Feb 2016 is assessed at PKR 22.33 billion. Amid the FY 2016, the administrative body OGRA has issued 12 licenses for operational promoting of capacity and filling plants, 37 licenses for development of LPG stockpiling and filling plants, 20 licenses for Construction of LPG auto re-fueling stations and one permit for capacity and re-fueling of LPG was issued. Further, one permit for development of generation and capacity of LPG office is likewise issued by OGRA which should bring about enhancing supply and appropriation of LPG and additionally make openings for work in the segment.

Table. 1. Energy Mix of Pakistan

Source	Electricity Generation (GWh)	Percent of total generation (%)
Oil	33,568	35.2
Gas	27,656	29
Hydel	28,514	29.9
Nuclear and imported	5531	5.8
Coal	95	0.1
Total	95,364	100

V. RENEWABLE ENERGY

Energy demand is increasing by more than 9% annually in Pakistan. It is expected that energy demand will increase 8-fold by 2030 and 20-fold by 2050 in Pakistan [1]. Today, only 55% of Pakistan's population has access to electricity. The nation is currently facing a 3 GW power supply shortage - the most severe energy crisis to ever hit the country. The occurrence of prolonged and frequent power outages has had a negative impact on industry operation, the economy and the livelihood of citizens in general [2]. While the energy shortage continues to grow, abundant indigenous sustainable energy resources such as wind, solar and biomass remain virtually untapped. The government attempted to promote the adoption of renewable energy technologies (RETs) in 2006 by implementing its first renewable energy policy. However, this policy has had limited success and faces a number of challenges. These policy challenges must be clearly identified and addressed in order to pave the way forward for a sustainable energy future in Pakistan.

Currently, approximately 66% of power generation in Pakistan is derived from fossil fuels (primarily oil and gas) followed by hydroelectricity (30%) and nuclear energy (3%). Hydro is the only sustainable energy resource which Pakistan employs for large-scale power generation. The implementation of the 2006 renewable energy policy has stimulated some interest in large-scale renewable power generation, but only one 50 MW wind energy project has been deployed in the Sindh region to date - that, too, with limited success. According to the International Energy Agency, global capacity of solar PV had reached 402 gigawatts (GW) at the end of 2017. It will further expand by almost 580 GW and lead the renewable electricity capacity growth [3].

Pakistan has four main renewable energy sources. These are wind, solar, hydro, and biomass. These resources have a significant potential to provide solutions to the long-lasting energy crisis in Pakistan [4]. Hence, a steady development of these resources is a crucial step to overcome the existing energy challenges in an environmental friendly manner. Among the different renewable energy sources, solar energy has received the most research attention [5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15]**.** Solangi et.al., [16] for instance, evaluated the potential of solar photovoltaic (PV) power generation capacity with 14 % efficient PV panels over area of 100 km^2, which is 0.01 % of total land area of the country. From the results, it was concluded that covering 100 km^2 area of land with PV panels can produce energy equivalent to 30 million tons of oil equivalent (MTOE) in Pakistan. Gondal et.al., [17], considered 0.45 % of urban regions for PV installations to estimate the total energy generation capacity based on solar PV system. A survey conducted by Ali et,al. [12] showed that the interior part of the county consists of mainly agricultural land, which is appropriate for the development of biomass feedstock, whereas northern and southern corridors have a significant potential for hydro, wind, and solar. This finding is useful as it might possibly improve the diverse energy supply market and decrease the dependency on imported fuels and environmental pollution. **Figure 2** shows the entire spectrum and end-uses of alternative sources which are the best options to meet basic requirements of energy needs, with various employment openings, local manufacturing.

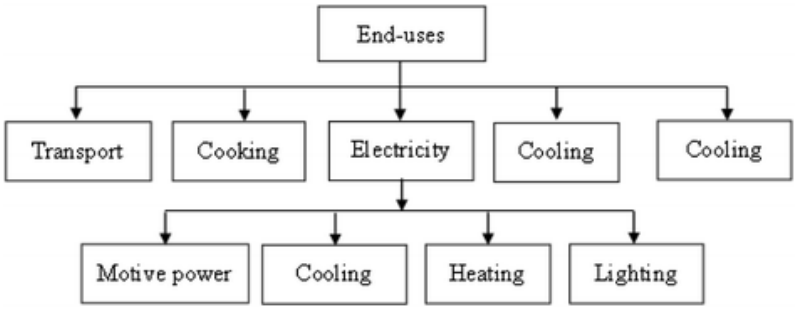

Fig. 2. End Uses of Renewable Energy Resources

It has been projected that Pakistan will contribute up to 10,000 MW to its energy mix through renewable energy resources by 2030. Therefore, timely and appropriate progress to exploit the potential of different natural energy resources will have a tremendously influence in meeting future projections

A. Solar Energy

Solar Energy is the radiation from the Sun equipped for creating heat, causing substance responses, or producing power. The aggregate sum of sun-oriented vitality episode on Earth is incomprehensibly in abundance of the world's present and foreseen vitality prerequisites. If reasonably bridled, this profoundly diffused source can possibly fulfill all future vitality needs. In the 21st century, sun-based vitality is relied upon to turn out to be progressively alluring as a sustainable power source because of its endless supply and its nonpolluting character, as a glaring difference to the limited non-renewable energy sources coal, oil, and petroleum gas.

a. Current Status and Resource Assessment:

Pakistan is amongst the richest countries in the world in terms of solar energy, having an annual global irradiance value of 1900–2200 kWh/m^2 [14]**.** Geologically Pakistan is located in the region of highest solar isolation in the world. Most of the areas receive high solar radiation intensities in a long season of summer [15, 16]**.** Much of Pakistan, especially Baluchistan, Sindh, and southern Punjab receives abundant solar irradiation on the order of over 2 MWh/m^2 and 3000 hour of sunshine a year, which is at the highest end of global insolation averages [17]**.** The estimated solar energy potential in Pakistan is over 100,000 MW [18]. Pakistan has great blessings of God especially it is idyllically situated in the sun-drenched belt and can get many benefits of solar energy technologies. The solar energy is lavishly obtainable in the mostly areas of the country. A daily

average of global irradiation falling on horizontal surface is about 200–250 watt per m^2. It is approximately 6840–8280 MJ/m^2 in a year**.** In our province of Baluchistan Sindh and Punjab are affluent in solar energy. Particularly in Baluchistan, the average daily global irradiation of 19–20 MJ/m2 a day and daily sunshine duration about of 8–8.5 h and these statistics are amongst the uppermost in the universe [19]**.** The said circumstances are idyllic for all solar energy applications including solar cell, solar cooker, solar heater, etc. [20, 21].

Contrary to the popular perception that solar energy is the cleanest renewable energy source, it pollutes the atmosphere through a massive use of materials like primary steel, glass and cement. It is estimated that solar thermal system requires more material per unit of energy than the fossil fuel plants [22]**.** Some of the materials used in solar energy system such as cadmium sulphide are explosive and toxic. Solar energy generation systems also pollute water by releasing antifreeze agents, rust inhibitors and leaching heavy metals. Solar energy system produces a number of non-recycle objects such as fiberglass, insulations and arsenic during decommissioning. Large scale photovoltaic power generation systems consume more water for cooling purposes and may disrupt the ground and surface water flow patterns. Such systems may also destroy desert habitats for burrowing animals and desert wildlife such as endangered species [23].

As regards the dispersed solar energy systems, it is considered the most benign source of energy. However, locating the solar home heating near evergreen trees could pose certain dangers to the atmosphere. Similarly concentrating rooftop collectors in a given area might change the albedo, which is ratio of reflected to incident light, and change the weather [23]**.** As regards greenhouse gases, solar energy system causes more greenhouse gas emissions initially than nuclear and fossil-energy systems [24] but in later stages it emits negligible greenhouse gases. There is a 2,900,000 MW solar energy potential due to Pakistan's geographical location with more than 300 sunshine days, 26-28Co average annual temperature and 1900-2200 kWh/m3 annual global irradiance. In 1980, Pakistan has the 18 photovoltaic (PV) systems with 440kW installed capacity. However, due to poor maintenance, carelessness and lack of knowledge, these systems did not remain functional for a long period. The government after that introduced prime minister solar villages in remote areas like villages in Baluchistan, Cholistan and some in Sindh, where electricity grid was not possible. Solar photovoltaic systems of 100500W/unit have been installed for electricity generation and water heating because water heating is energy intensively consumed almost 10% of total primary energy supply [25]**.**

That is why in 2013 import for solar water heaters increased from 260 in 2007 to 16715. Pakistan council of renewable energy technologies (PCRET) and Alternative energy development board (AEDB) are renewable energy development organization. AEDB has 200 kW total PV power generation, PCRET has 80 KW, while private sectors have 500kW total power generation [26]**.** So far, Pakistan has been increasing share of solar energy but remarkable and giant steps are still required for this sector to decrease the load shedding duration. Below **Figure 3** shows the generation and capacity of solar energy in Pakistan since 2015.

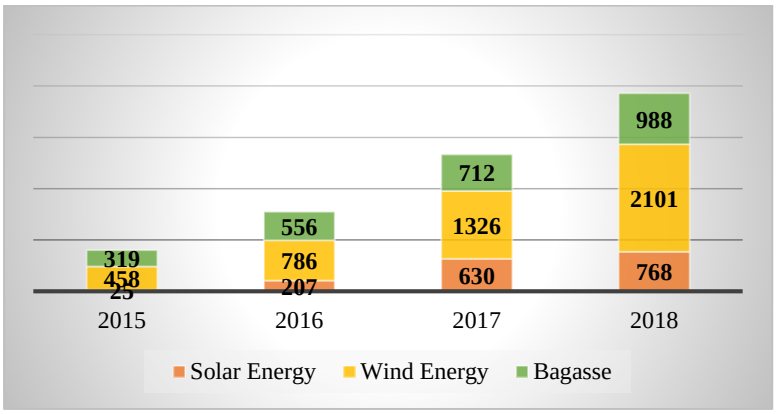

Fig. 3. Solar Energy Generation (GWh) and Capacity (MW)

Source: HDIP, 2017-18

b. High Insolation in Pakistan

Pakistan with a land area of 796,096 km^2 is located between longitudes 62° and 75° east and latitudes 24° and 37° north [27]**.** This unique geographical position and climate conditions is advantageous for the exploitation of solar energy. Almost every part of the country receives 8–10 h day^{-1} high solar radiations with more than 300 sunshine days in a year [14, 28]. **Figure 4** illustrates the range of solar radiation levels per month in the major cities of Pakistan [29].

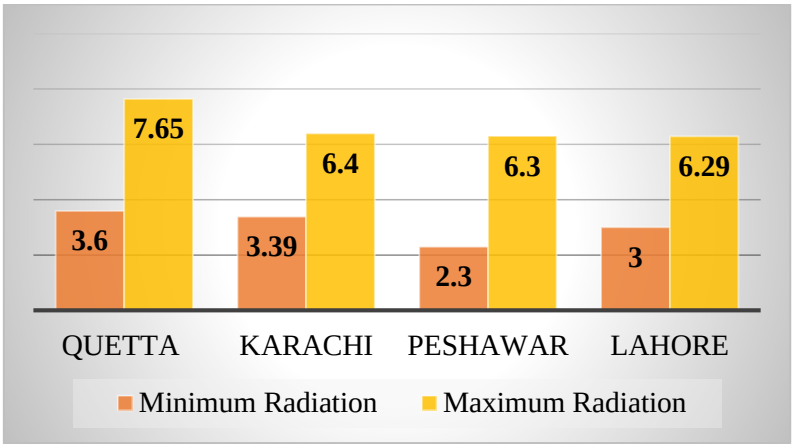

Fig. 4. Minimum and Maximum Range of Solar Radiation in Pakistan

Source: Nasir and Raza, 1993

Insolation in Pakistan is high as it falls on the Global Sun Belt and has substantial sun oriented vitality potential with a scope of 5.5 kWh/m²/day to 7 kWh/m²/day. Pakistan has likewise set an objective to include 5% roughly 10,000 MW power through sustainable power sources by year 2030 other than supplanting of 5% diesel with bio-diesel by year 2015 and 10% by 2025.

Sun oriented Village Electrification Program was started under PM's order. 3000 Solar Home Systems have been introduced in 49 towns of area Tharparkar, Sindh. Another 51 towns in Sindh and 300 towns in Baluchistan are avowed for charge using sun fueled essentialness and will be realized on entry of benefits

c. Prospects of Solar Energy in Pakistan:

The prospects of solar energy in Pakistan have also been widely investigated by many researchers [29, 26, 30, 31, 32, 33, 34]**.** Adnan et al. [31] analyzed the magnitude of solar radiation data for 58 different PMD stations, and the data showed that over 95 % of the total area of Pakistan receives solar radiations of 5–7 kWh m^{-2} day^{-1}.

Ahmed et al. [32] and Ahmed et al. [33] different methods to estimate and characterize direct or diffused solar radiations in many parts of the country. Khalil and Zaidi [34], conducted the survey of wind speed and intensity of solar radiations at different locations of country. Furthermore, the data was then compared among wind turbine (1 kVA), solar PV (1 kVA), and gasoline generator (1 kVA) **(Table 2).** The comparison showed that the wind and solar energy are most appropriate alternative resources. The study also found that the 1 kW of solar PV can produce 0.23 kW of electricity, which can significantly contribute to reduce load shedding in Pakistan. Hasanain and Gibbs [35] detailed out the significance of solar energy in rural areas of the country.

	Price (USD)	Fuel cons: (USD/h)	Maintenance cost (USD/h)	Life (years)	CO_2 (g/l)	NO_2 (g/l)
Solar panel (1 kVA)	632	0	0	25	0	0
Gas generator (1 kVA)	1067.50	1.08	0.06	3–5	6.4	58
Wind turbine (1 kVA)	1165.44	0	0.03	12–15	0	0

Table 2: Running Cost Evaluation for Different Energy Sources

Source: Khalil and Zaidi, 2014

AEDB has estimated that Pakistan has about 2,900,000 MW (2900 GW) of solar power potential [36]. The main obstacles to full-scale exploitation include

i. High cost
ii. Lack of technology
iii. Socio-political behaviors
iv. Governmental
v. policy conflicts.

In 2003, the chief minister of Punjab launched the "UJAALA" program, where 30 W PV panels were distributed among university students throughout the country. This program aimed at encouraging people to utilize alternative energy and cut-down their dependency on the national gird. Another project introduced by the government was the "Quaid-e-Azam solar park." This solar park is built to produce 2000 MW of electricity by 2015 [34]. It is projected that the largest solar photovoltaic electricity production will be established after 2020 [37]**.** PCRET has set up approximately 300 solar PV units of 100 kW capacities to power 500 homes, colleges and mosques, including street lighting [38]**.** AEDB has powered 3000 families by installing 200 kW PV system together with 80 W solar charged lighting systems. Many NGOs are effectively working to install PV units in several parts of the country. The solar street lamps and solar charging lights for households are particularly of major interest. Pakistan has a target of electrifying approximately 40,000 villages via solar PV by 2015 [26].

The perfect utilization of solar energy resources are the two provinces, one is Sindh and second is Baluchistan. According to survey of federal bureau, the 77% are the rural population in the province of Baluchistan [37,40]. The population concentration is slightly very small. There is still about 80% the villages of Baluchistan are yet needed the electricity. The main reason is also that these villages are alienated by large distances. There are no such connecting roads. Therefore, it is very expensive to connect them through any transmitting lines. In the villages of Baluchistan, the mostly houses are hut/shed type. In addition to food things, electricity is also major need for those peoples. Commonly these houses consist of single room. The electricity for each house is about from 50 to 100 W maximum [40, 41] **(Raza et al., 2009, World Renewable Energy Council, 2000).** It is not economical to provide electricity to individuals. Therefore, the solution for these peoples is the only install small-scale power generation systems like solar cells. If diesel generators are used, again there are many problems like transportation of fuel and maintenances and these things make it again expensive. Due to all above said problems, we can say that the solar energy is the only and most excellent solution. One effort also from government is that about 100 homes near the capital of Pakistan, Islamabad are transformed over to solar power to test a new model for the electricity supplying to the people of Pakistan [40]**.**

d. Uses of Solar Energy in Urban cities:

Solar energy can be used be urban cities for domestic and commercial uses. Solar energy can be used as a fuel also.

1. Solar Indoor Lights:

We can consume a considerable measure of costly vitality utilizing consistent lights inside your home. Sun powered indoor lighting is an ecologically well-disposed and reasonable choice in reality as we know it where it has turned out to be vital that we search out option vitality sources. Rather than utilizing overhead lights, utilize sun based controlled work area and floor lights to illuminate your home around evening time. Like the open air form, these indoor lights catch light vitality amid the day and store it in little batteries which the lights.

2. Solar Chargers For Electronics:

Indeed, our mobile phone, tablet, MP3 players and numerous other electronic gadgets can be accused of sun oriented power. There is a few sun based controlled chargers available that either charge inward batteries, (as in PDAs) or charge C, D, AA, and AAA batteries for use in other electronic gadgets.

3. Solar Water Heater:

For a fraction of the cost of a complete solar-power system, a solar-powered water heater system can be installed to generate hot water for home uses.

4. Solar Oven:

Solar energy is also used for cooking purpose for these small ovens are made. These small stoves can cook sustenance at a temperature of up to around 350 degrees and are completely sun based fueled.

5. Street Lights:

Solar panels can also be putted in street poles so that the electricity the lights are using should be from solar energy. Road signs can also be converted on solar energy.

6. Satellites:

A satellite needs electrical power to operate and this electrical power can be gained from solar energy. In space without air and clouds the sun rays are more powerful. So a large number of energy can be produce and utilized in satellites.

These were some random uses of solar energy but it could be used on a large scale on commercial and domestic level.

e. Current Solar Projects:

i. Quaid-E-Azam Solar Park:

The Punjab government set up the Quaid-e-Azam Solar Park over a region of 10,000 sections of land in the Cholistan Development Authority in Bahawalpur, Punjab. Quaid-e-Azam Solar Park Project in Bahawalpur will begin creating 300 MW of power before the finish of 2015. As of now it is creating more than 100 MW. Its aggregate limit will be 1000 MW. The Quaid-e-Azam sunlight based stop will create 1000 MW before the finish of 2016.

ii. Pakistan's Parliament Solar Project:

The venture is being supported by the Chinese government as a signal of companionship and an affirmation of the long standing Pak-China fellowship. As indicated by points of interest, venture was finished with over Rs.500 million that is supported by Chinese government while it will spare Rs.28 million every year in vitality costs. Its aggregate limit is 1.2 MW. Pakistan has an after death to have first Parliament on the planet that goes sun oriented in April 2015.

iii. Conergy Solar Project:

German Solar Company Conergy has joined forces with Hong Kong based vitality arrangements supplier, venture designer Ensunt Holdings to actualize a 50 megawatt (MW) sun powered power plant in Bahawalpur for the US-based option vitality firm DACC Global Power Generation Company Limited (DPGCL).

iv. Scatec Solar Project:

On the event of visit of Prime Minister Nawaz Sharif to Norway, Oslo, an assention was marked between Mr. Raymond Carlsen, CEO of Oslo-headquartered Scatec Solar ASA (SSO) and Mr. Usman Ahmad, CEO of Karachi-based Nizam Energy (Pvt.) Ltd on the benefit of their organizations to assemble a 150 MW sun powered plants which are relied upon to be finished towards the finish of 2015, with development beginning in the main quarter of 2016. The photovoltaic plants include an underlying venture of about $300 million.
The undertakings, involving three plants producing 50MW each, are to be finished in about a year. An extra 150MW is intended to be produced in a moment organize, bringing the aggregate venture to about $600 million. The 150 MW plants will have the capacity to control around 150,000 homes amid top hours.

The marking service occurred within the sight of Norwegian Prime Minister Ms. Erna Solberg and Prime Minister Mr. Nawaz Sharif.

v. JS Bank Solar Branches:

JS Bank has been attempting to supply its branches through Solar Power. The first of numerous such arranged branch changes the country over was the Dhoraji branch Karachi in 2013. Inside two years, the bank has scored a century and changed over its 100 branches from ordinary electric energy to Solar Energy. This has made it conceivable to have continuous power supply for PCs, servers, ATMs and teller stations.

vi. Roshan Power (Pvt.) Ltd. Owned By Beacon House Group:

The Undertaking Improvement of 10 MW Sunlight based PV Power Task in Kasur, Punjab, Pakistan is in process. The credibility of the Undertaking is submitted and supported from Punjab Power Advancement Board (PPDB). The assignment is has associated for frank require and Age Permit application to NEPRA. The letter of point (LIO) has been issued.

vii. Buksh Energy Solar:

Alternative Energy Development Board (AEDB) has conceded the nation's first LoS to Buksh Solar Pvt. Ltd. (BSPL) for its 20 MW sun powered fueled age office cooking toLodhran, Punjab. Buksh Solar is an exceptional reason vehicle of Buksh Energy Pvt. Ltd. exclusively setup to encourage the 20 MW Solar IPP that would pitch power to Multan Electric Power Company (MEPCO). The proposed task will have an introduced limit of 10 Megawatts (MW), of which the vitality delivered will be conveyed to MEPCO. The proposed control plant would utilize sun powered power as a fuel to create power and will utilize cutting edge innovation delivering 16,731MW power for every annum.

viii. First solar (pvt.) Ltd:

Wander Advancement of 2 MW Sun based PV Power Venture in Kallar Kahar, Punjab, Pakistan is in process. The likelihood of the endeavor is submitted to AEDB.

ix. JK power (pvt) Ltd owned by JK spinning mills limited:

Wander Advancement of 10 MW Solar PV Power Venture in Faisalabad, Punjab, Pakistan is in process. The organization has as of late got LOI from Punjab Power Development Board. The possibility of the Project is in advance.

x. Hanergy global solar asia pacific limited, china:

Venture Advancement of 10 MW Solar PV Power Project in Pind Dadan Khan Punjab in Pakistan is in Progress. The organization has as of late got LOI from Alternative Energy Development Board. The place where there is the undertaking is nearly concluded and possibility of the tasks is in advance.

xi. Hanergy global solar asia pacific limited, china:

Venture Advancement of 50MW Solar PV Power Project in Pind Dadan Khan, Punjab in Pakistan is in Progress. The organization has as of late got LOI from Alternative Energy Development Board. Land choice is in advance.

xii. MI solar (pvt.) Ltd:

Venture Advancement of 20 MW Solar PV Power Project in Jamshoro, Sindh, Pakistan is in progress. The association is full time specialized help to the venture. The undertaking is right now at permitting and duty arrange.

xiii. Gul Ahmed solar power Ltd (GASPL):

Venture Advancement of 100 MW Solar PV Power Project in Jhimpir, Sindh, Pakistan is in process. The achievability of the venture has been submitted to DAE-GoS. The inclusion is full time specialized help to the venture. The undertaking is at present at permitting and duty organizes.

xiv. Metro Solar Power Ltd (MSPL):

Undertaking Advancement of 50 MW Solar PV Power Project in Jhimpir-Sindh, Pakistan is in process. The practicality of the undertaking has been submitted to DAE-GoS. The inclusion is full time specialized help to the undertaking. The undertaking is as of now at permitting and levy organizes.

xv. 400 MW Solar Project By China Three Gorges South Asian Investments Ltd (CTGSAIL):

RE2 has quite recently marked the arrangement of aggregate 400 MW Solar PV Project in Sindh supported by CTGSAIL. The undertaking is at beginning phases of advancement. Right now the Land appraisals in Southern piece of Pakistan are in process.

xvi. Forshine solar Pakistan (pvt) ltd:

Undertaking Development of 50 MW Solar PV Power Project in Thatta Sindh, Pakistan is in process. The practicality of the undertaking has been submitted to AEDB. The association is full time specialized help to the task. The task is as of now at authorizing and tax arrange.

VI. CONCLUSION

The Sustainable and Clean energy supply in upcoming years is turn out to be the big challenge for developing countries. The current energy situation in Pakistan really needs renewable energy and new energy power plants. Due to environment health and low economy we should have to work on renewable energies. Pakistan has very sunny areas so solar are very appropriate for energy making. Solar sites are also mentioned in the paper. The solar energy, solar types are also discussed so that we can use appropriate technology for our requirements.

Understanding the importance of imperativeness, the lawmaking body is attempting all undertakings to achieve the whole deal vision of the power division to beat its challenges. The change of indigenous essentialness resources, for instance, coal, hydro, elective and boundless sources, is fundamental for practical monetary improvement, as visualized in the Vision 2025. The China-Pakistan Economic Corridor (CPEC) is expected to add 10,400 MW to the grid by the year 2018.

Following are the barriers in accomplishing the sustainable and clean energy technology. These may be market, technical, social acceptance and political regulatory barriers. Some of them are:

- Transmission access restricted due elevated price
- Lacking of technical expertise
- Capital investment due to finance
    - Restriction on installation and construction of environmental friendly equipments like solar geyser, roof solar heaters etc.
- Lack of Institutional coordination between government bodies
- Public awareness
- Unavailability of resources which leads to the deadlock of alternative renewable energy technologies.

NEPRA, AEDB and PCRET are the operational governing bodies for the alternative energy mix of Pakistan but these organizations need perfection in institutional coordination. The resources we are using are also discussed in the paper. The advantages and disadvantages of these resources are in front of us, now it's our duty which resource we should have to use. Should be use that technology or resources which damage our environment or we should use environment friendly technologies. The current solar projects are giving good results. JS Bank is a symbol of environment friend organization which is also working on solar to make our environment good.

Recommendation**:**

1. Government of Pakistan should focus on for short term solution to energy crisis.
2. Alternative energy is the real solution to Pakistan's perpetual energy crises.
3. Coastal belt of Sindh and Baluchistan is blessed with abundant of sunshine which can be utilized to produce solar energy in adequate amount.
4. Industries which are consuming energy more than 32% should adopt Energy conservation systems an management plans and measures.
5. Government buildings can be converted to utilize solar energy like parliament house, governor house, secretriats, assemblies etc.

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